

Theoretical interpretation of the results of an experimental search for the Jacobi shape transition in rapidly rotating nuclei

W. J. Swiatecki

In a collaboration with experimentalists at the 88" cyclotron [1, 2, 3] a model of rapidly rotating nuclei was further refined. The experiments consisted of measurements of quasi-continuous gamma radiations emitted from reactions of ^{48}Ca beams on targets of ^{50}Ti , ^{64}Ni , ^{96}Zr and ^{124}Sn . The bombarding energies were in the range of 195 – 215 MeV, chosen so as to bring in a high angular momentum without severe fragmentation of the cross-sections for fusion reactions. The results were analyzed in a variety of ways, with the consistent result that in all but the heaviest target, the nuclear moments of inertia tend to increase with increasing angular momentum up to the highest values observed. The experiments were motivated by the theoretical prediction of an abrupt, angular-momentum induced transition of the configuration of a rotating fluid from a slightly oblate shape to a rapidly elongating triaxial figure at a critical angular momentum. (This is the transition discovered by C. G. J. Jacobi in 1834 in the context of idealized gravitating masses.)

Two theoretical models were developed for comparison with the data. The first consisted of a generalization of the Thomas-Fermi self-consistent, semi-classical model, which is known to give an excellent approximation to average nuclear properties of non-rotating nuclei [4]. The generalization consists of adding a rotational energy term corresponding to synchronous rotation, where all mass elements are assumed to rotate with the same angular velocity. The second model incorporates a refinement that attempts to represent the effect of nuclear pairing on the moments of inertia at relatively low angular momenta. The second model, unlike the first, gives a fair representation of the measured gamma ray transitions in their dependence on angular momentum. This comparison suggests that, at the highest angular momenta studied, one may be entering the unfamiliar Jacobi regime of rapidly elongating configurations, in which the angular velocity is a *decreasing* function of the angular momentum.

- [1] D. Ward, W. J. Swiatecki, R. M. Diamond et al., *Search for the Jacobi transition in rapidly rotating nuclei, 1. Experiment*, Proc. Int'l Conference INPC, Berkeley, Aug. 2001.
- [2] D. Ward, W. J. Swiatecki, R. M. Diamond et al., *Search for the Jacobi transition in rapidly rotating nuclei, 2. Interpretation*, Proc. Int'l Conference INPC, Berkeley, Aug. 2001.
- [3] D. Ward, W. J. Swiatecki, R. M. Diamond et al., *Search for the Jacobi transition in rapidly rotating nuclei*, being submitted to Phys. Rev. C.
- [4] W. D. Myers and W. J. Swiatecki, Nucl. Phys. **A601**, 141 (1996).